

Photograph all of the waveform monitor displays from which data were taken.

The DVTR recordings, made in Section 3.3.1.3, need not be repeated.

### **3.3.3 Luminance Response to Moving Step**

The procedure released for comment in the September 14, 1989, revision of this document, has been withdrawn. Strong reservations were expressed by some proponents concerning the validity of all measurement procedures using moving test patterns. A scientifically valid method that is also practical to implement by ATTC is currently under study.

### **3.3.4 Luminance Response to Moving Pulse**

The previously released measurement procedure has been withdrawn. (See Section 3.3.3.) An alternative procedure is under study.

### **3.3.5 Chrominance Response to Stationary Step**

#### **3.3.5.1 Setup**

Two setups are required for measuring this parameter, and the complete procedure must be executed twice -- once for each setup.

For all measurements, connect the Red, Green, and Blue outputs of the PIXAR to the respective inputs of the SUT.

For the first set of measurements, connect the Red output of the SUT to the waveform monitor. Terminate the cable in 75 ohms. Using matrix coefficients supplied by the proponent, set the amplitudes of the PIXAR outputs such that only the "R-Y" (or "I") color-difference channel of the SUT is modulated with an AC waveform, and the "B-Y" (or "Q") and luminance channels have a constant-amplitude signal over the entire area of the test pattern.

For the second set of measurements, connect the Blue output of the SUT to the waveform monitor. Terminate the cable in 75 ohms. Using matrix coefficients supplied by the proponent, set the amplitudes of the PIXAR outputs such that only the "B-Y" (or "Q") color-difference channel of the SUT

is modulated with an AC waveform, and the "R-Y" (or "I") and luminance channels have a constant-amplitude signal over the entire area of the test pattern.

The output of the reference NTSC demodulator remains connected to the NTSC waveform monitor for all measurements. Two types of decoder are required for NTSC chrominance measurements. This may imply the use of two instruments, one having a comb filter and the other having a band-pass filter.

The "picture monitor output" of each waveform monitor remains connected to the corresponding picture monitor for all measurements. An active video gate must be connected between each waveform monitor and its picture monitor, for photography of the picture monitor.

Select PIXAR test pattern No. \_\_\_\_\_. This pattern contains an array of pulses and windows of different widths and orientations. The peak amplitude of these signals is 700 mV above the blanking-level base line.

### **3.3.5.2 Measurement Technique**

For each procedure below, first exercise the "R-Y" (or "I") channel of the SUT and take measurements from both the ATV and the NTSC monitors. Then, exercise the "B-Y" (or "Q") channel and take measurements from both the ATV and the NTSC monitors.

The ATV procedures are identical to the corresponding procedures for luminance. For the NTSC procedures, the chrominance envelope must be observed on the waveform monitor. Use the comb filter instrument to make horizontal measurements. Use the band-pass filter instrument for vertical measurements.

#### **3.3.5.2.1 Horizontal Transient Response**

Measure the transient response at the ATV (Red and Blue) outputs, following the procedure of Section 3.3.1.2.1.

In order to measure the response at the NTSC demodulator output, it is necessary to separate the chrominance component with a comb filter having a broad bandwidth for horizontal spatial frequencies. Using a waveform monitor that incorporates such a comb filter, select the

"chroma" filter setting to display the envelope of the chrominance signal. Then, follow the procedure of Section 3.3.1.2.1, measuring the specified parameters with respect to the envelope of the displayed waveform.

#### **3.3.5.2.2 Vertical Transient Response**

Measure the transient response at the ATV (Red and Blue) outputs, following the procedure of Section 3.3.1.2.2.

In order to measure the response at the output of the NTSC demodulator, it is necessary to separate the chrominance component with a band-pass filter, rather than a comb, so that the vertical response is not affected by the filter. Using a waveform monitor that incorporates such a band-pass filter, select the "chroma" filter setting to display the envelope of the chrominance signal. Then, follow the procedure of Section 3.3.1.2.2, measuring the specified parameters with respect to the envelope of the displayed waveform.

#### **3.3.5.3 Presentation of Data**

Record, in normalized units, all of the parameter values obtained from both the ATV and NTSC receiver outputs in the above procedures. The data should cover both horizontal and vertical transient response, at all four attenuator settings, for both color-difference signals.

Photograph all of the waveform monitor displays from which data were taken.

For each of the two inputs, and each of the four attenuator settings, make a 30-second recording on the HD-DVTR and on the NTSC-DVTR. Note the SMPTE time code at the start of each recording.

### **3.3.6 Chrominance Response to Stationary Pulse**

#### **3.3.6.1 Setup**

The setup required for these measurements is identical to that described in Section 3.3.5.1.

### **3.3.6.2 Measurement Technique**

For each procedure below, first exercise the "R-Y" (or "I") channel of the SUT and take measurements from both the ATV and the NTSC monitors. Then, exercise the "B-Y" (or "Q") channel and take measurements from both the ATV and the NTSC monitors.

#### **3.3.6.2.1 Horizontal Transient Response**

Measure the transient response at the ATV (Red and Blue) outputs, following the procedure of Section 3.3.1.2.1.

Measure the response at the NTSC demodulator output, using a waveform monitor that incorporates a comb filter. Select the "chroma" filter setting to display the envelope of the chrominance signal. Then, follow the procedure of Section 3.3.1.2.1, measuring the specified parameters with respect to the envelope of the displayed waveform. By always observing the middle line, among a group of consecutive lines that contain the same horizontal signal, the effect of the comb filter on vertical response does not impair the measurement.

#### **3.3.6.2.2 Vertical Transient Response**

Measure the transient response at the ATV (Red and Blue) outputs, following the procedure of Section 3.3.1.2.2.

Measure the response at the NTSC demodulator output, using a waveform monitor that has a band-pass "chroma" filter. Select this filter setting to display the envelope of the chrominance signal. Then, follow the procedure of Section 3.3.1.2.2, measuring the specified parameters with respect to the envelope of the displayed waveform.

### **3.3.6.3 Presentation of Data**

Record, in normalized units, all of the parameter values obtained from both the ATV and NTSC receiver outputs in the above procedures. The data should cover both horizontal and vertical transient response, at all four attenuator settings, for both R-Y and B-Y input excitation.

Photograph all of the waveform monitor displays from which data were taken.

For each of the two inputs, each of the four attenuator settings, and each of the two axes of pattern movement, make a 30-second recording on the HD-DVTR and on the NTSC-DVTR. Note the SMPTE time code at the start of each recording.

### **3.3.7 Chrominance Response to Moving Step**

The previously released measurement procedure has been withdrawn. (See Section 3.3.3.) An alternative procedure is under study.

### **3.3.8 Chrominance Response to Moving Pulse**

The previously released measurement procedure has been withdrawn. (See Section 3.3.3.) An alternative procedure is under study.

### **3.3.9 Luminance Temporal Response**

#### **3.3.9.1 Setup**

Connect the output of the test signal generator, through the attenuator and the active video gate, to the Red, Green, and Blue inputs of the SUT. Use a wideband video distribution amplifier driving equal lengths of identical coaxial cable into 75-ohm terminations at the encoder input.

Connect the logic output of the active video gate to a trigger input of the oscilloscope.

Connect the Green output of the SUT to the ATV waveform monitor, as a signal conditioner. Connect the picture monitor output of the waveform monitor to one input channel of the oscilloscope. Terminate both cables in 75 ohms.

Connect the output of the reference NTSC demodulator to an NTSC waveform monitor having a picture monitor output or auxiliary output, to be used as a signal conditioner. Connect either waveform monitor output to another input channel of the oscilloscope. Terminate both cables in 75 ohms.

Select a 700-mV flat-field test signal.

### **3.3.9.2 Measurement Technique**

Set both waveform monitors for fast DC restoration. Select DC coupling for both oscilloscope video inputs.

Set the active video gate to pass 16 out of 32 frames (16 on; 16 off).

Set the attenuator at the 0-dB position.

Select the ATV signal for viewing on the oscilloscope, and adjust the time base so that several frames of the video signal are displayed. Adjust the trigger delay, slope, and level controls so that the off-to-on transition of the flat field can be observed. If necessary, expand the time base to display all frames on which a transient level is observed. Obtain a photograph of the oscilloscope display.

Select the NTSC signal for viewing, and repeat the procedure.

Re-adjust the trigger controls to display the on-to-off transition of the flat field. Obtain photographs of the display for both the ATV and NTSC signals.

Repeat the steps in the three paragraphs above, for attenuator settings of 3-dB, 6-dB, and 12-dB.

### **3.3.9.3 Presentation of Data**

In addition to the photographs taken above, documentation of these tests should include DVTR recordings, both HD and NTSC. Make 30-second recordings, and note the SMPTE time code at the start of each recording.

## **3.3.10 Chrominance Temporal Response**

### **3.3.10.1 Setup**

Two setups are required for measuring this parameter, and the complete procedure must be executed twice -- once for each setup.

For all measurements, connect the Red, Green, and Blue outputs of the PIXAR to the respective inputs of the SUT.

For the first set of measurements, connect the Red output of the SUT to the waveform monitor. Terminate the cable in 75 ohms. Using matrix coefficients supplied by the proponent, set the amplitudes of the PIXAR outputs such that only the "R-Y" (or "I") color-difference channel of the SUT is modulated with the transient waveform, and the "B-Y" (or "Q") and luminance channels have a constant-amplitude DC signal.

For the second set of measurements, connect the Blue output of the SUT to the waveform monitor. Terminate the cable in 75 ohms. Using matrix coefficients supplied by the proponent, set the amplitudes of the PIXAR outputs such that only the "B-Y" (or "Q") color-difference channel of the SUT is modulated with the transient waveform, and the "R-Y" (or "I") and luminance channels have a constant-amplitude DC signal.

For both setups, connect the logic output of the active video gate to a trigger input of the oscilloscope. Connect the output of the NTSC demodulator to an NTSC waveform monitor having a picture monitor output or auxiliary output, to be used as a signal conditioner. Connect either waveform monitor output to another input channel of the oscilloscope through a color-subcarrier band-pass filter. Use a short cable between the filter and the oscilloscope input. Terminate both cables in 75 ohms.

Select a 700-mV flat-field test signal.

#### **3.3.10.2 Measurement Technique**

For this procedure, first exercise the "R-Y" (or "I") channel of the SUT and take photographs of both the ATV and the NTSC demodulator output waveforms. Then, exercise the "B-Y" (or "Q") channel and take photographs of both the ATV and the NTSC demodulator output waveforms.

Use the technique described in Section 3.3.9.2. Note that the chrominance envelope, rather than a baseband signal, is being observed at the NTSC output.

**3.3.10.3 Presentation of Data**

In addition to photographs, documentation of these tests should include DVTR recordings, both HD and NTSC, for each input. Make 30-second recordings, and note the SMPTE time code at the start of each recording.

## **4. Chromaticity/Colorimetry Characteristics**

### **4.1 Introduction**

The procedures in this section exercise the Red, Green, and Blue inputs of the system under test, to explore the dynamic range over which the chrominance channels are linear. In addition, for those systems that are "NTSC compatible," the procedures determine whether standard NTSC color-difference signals are present at the output of a reference-quality NTSC demodulator.

In conjunction with these tests, information is required from the proponent as to the degree of NTSC compatibility that is claimed.

### **4.2 Test and Measuring Equipment**

#### **4.2.1 Signal Sources**

Two different signals are required for the procedures that follow.

The first signal is RGB color bars of 75-percent amplitude (525 mV) and zero setup. In CCIR nomenclature, these are 75/0/75/0 bars. A suitable source of this signal is \_\_\_\_\_.

The other signal is a line-rate ramp that increases linearly in amplitude, from the 0-mV black level to the 700-mV white level, during the period from 10 percent to 90 percent of the active line time. The waveform is specified in Figure \_\_. This signal is generated by the PIXAR.

Three matched attenuators, having settings of 0 dB and 1 dB, are required for the test with color bars.

A calibrated wideband attenuator, having integer and 0.1-dB steps, may be required for the dynamic range test.

#### **4.2.2 Monitoring**

For the NTSC-compatibility test, a professional, reference-quality NTSC demodulator, an NTSC waveform monitor, and an NTSC vectorscope are required. Use of a video measurement set that integrates the waveform monitor and

vectorscope functions, provides automatic measurement of amplitude and phase, and generates a hard-copy output, is recommended.

For the dynamic range test, an ATV waveform monitor is required. A differentiating filter, having a time constant of approximately one microsecond, should be available for insertion ahead of the monitor input. A specification for a suitable filter is provided in Figure \_\_.

### **4.3 Procedures**

#### **4.3.1 Color Difference Compatibility**

##### **4.3.1.1 Setup**

Connect the Red, Green, and Blue outputs of the color-bar generator, through the the three matched attenuators, to the respective inputs of the system under test. Use equal lengths of identical coaxial cable into 75-ohm terminations at the encoder input.

Connect the output of the reference NTSC demodulator to the NTSC waveform monitor and vectorscope. Terminate all cables in 75 ohms.

##### **4.3.1.2 Measurement Technique**

Set the attenuators to the 0-dB position.

Adjust the gain and phase controls of the vectorscope to center the Green dot in the appropriate box of the graticule. Note the phase and amplitude of each of the other vectors on the vectorscope display.

Set the attenuators to the 1-dB position.

Increase the gain of the vectorscope to return the Green vector dot to the original position.

Measure any differences, in amplitude or phase, between the dot positions now displayed and the original positions.

#### **4.3.1.3 Presentation of Data**

For each attenuator setting, photograph the waveform monitor, showing a line-rate display, and the vectorscope, with the Green dot positioned in the box.

Make a 15-second recording on the NTSC DVTR at each attenuator setting. Note the SMPTE time code at the start of each recording.

### **4.3.2 Chrominance Component Dynamic Range**

#### **4.3.2.1 Setup**

Connect the output of the PIXAR to the Red, Green, and Blue inputs of the SUT. Use a wideband video distribution amplifier driving equal lengths of identical coaxial cable into 75-ohm terminations at the encoder input.

The procedure below must be performed three times, once each for the Red output, Green output, and Blue output. For each iteration, connect the appropriate output of the SUT to the ATV waveform monitor and terminate the cable in 75 ohms.

#### **4.3.2.2 Measurement Technique**

Examine each of the three ATV outputs, in turn, on the waveform monitor. Nonlinearity of the transfer characteristic is evidenced by distortion of the ramp signal. Nonlinearity near the peak amplitude of the ramp is indicated by compression or, in the extreme case, clipping of the ramp. Nonlinearity near black is evidenced by curvature of the ramp, or a delay in the start-up of the ramp from black, or both.

A small amount of nonlinearity is more easily discernible if the differentiating filter is placed in line with the waveform monitor input.

If any nonlinearity is observed, on any output, place the calibrated wideband attenuator in line with the corresponding input of the SUT. Increase the amount of attenuation until there is no discernible nonlinearity on the ATV output. Note the attenuation required to achieve this condition.

**4.3.2.3      Presentation of Data**

Photograph the waveform monitor display of any output that shows nonlinearity. Record the attenuation required to reduce the nonlinearity below an observable level.

Make a 15-second recording on the HD DVTR, both before and after any attenuation to correct nonlinearity. Note the SMPTE time code at the start of the recording(s).

## **5. Aspect Ratio**

The procedure released in the September 14, 1989, revision of this document has been withdrawn. It is the opinion of ATTC that this attribute is a declared property of each proponent ATV system. Furthermore, reproduction of a properly sized image is a receiver implementation issue, rather than a function of the transmission system. For these reasons, this attribute should not be subject to testing by ATTC.

## **6. Transmitted Signal Bandwidth**

### **6.1 Introduction**

Refer to the Functional Diagram for the Advanced Television Test Center facility, Figure \_\_. The output of each proponent-provided ATV modulator occupies an IF band nominally between 41 and 47 MHz. The main channel typically occupies the full 6-MHz bandwidth, while an augmentation channel may occupy only half of that bandwidth. It is the responsibility of the proponent to band-pass filter each modulator output appropriately to ensure compatibility with FCC requirements for radiated signals.

The procedure described below measures the spectrum of each IF signal provided to the RF Test Bed by a proponent system.

#### **6.1.1 Definition**

**Transmitted Signal Bandwidth** is the bandwidth of the signal applied to the antenna of a terrestrial television broadcast facility. This signal includes all video, audio, and data carriers, as well as any "helper" signals used to convey enhancement information.

#### **6.1.2 General Description of Method**

All carriers are modulated with appropriate test signals, described by the proponent, to fill the transmitted spectrum with sideband energy. The spectrum, at the output of the proponent-supplied band-pass filter, is measured and plotted. Using an appropriate power measurement method, specified by the proponent, the half-power bandwidth is determined. The procedure is repeated for each channel of a multiple-channel system.

## **6.2 Test and Measuring Equipment**

A suitable test instrument for this procedure is a spectrum analyzer that covers a frequency range of 41 MHz to 47 MHz.

### **6.3 Procedure**

#### **6.3.1 Setup**

The proponent shall have described an appropriate test signal to maximize the energy and bandwidth of the transmitted signal. Select such a signal as the input to the proponent-furnished encoder.

As a default test signal, select a matrix test pattern, or "multi-pattern," as the video signal input to the encoder. This test pattern incorporates a variety of standard luminance and color test signals, such as crosshatch, checkerboard, multiburst, and color bars. It occupies the full image area, including the side panels. This pattern may be made dynamic, to maximize energy and bandwidth for motion-adaptive systems, by gating it on and off at one-frame intervals with the active video gate as described in Section 2.2.1.2.

Apply pseudo-random digital data to all digital audio and ancillary data inputs.

Connect the IF output of the proponent system to the spectrum analyzer. Take care to match the input impedance of the spectrum analyzer, which may be 50 ohms, to the 75-ohm output impedance of the proponent system.

#### **6.3.2 Measurement Technique**

With all carriers excited as specified above, display the spectrum of the IF signal on the spectrum analyzer. Using the power measurement method specified by the proponent as appropriate for the system under test, note the half-power (3-dB) bandwidth of the signal.

Repeat this procedure for each channel in a multi-channel system.

#### **6.3.3 Presentation of Data**

For each channel, photograph the spectrum analyzer display or obtain a hard-copy output from a printer or plotter, if the instrumentation provides this capability.

## **7. NTSC-Compatible Sync/Blanking/Subcarrier Timing**

The procedure released in the September 14, 1989, revision of this document has been withdrawn. That procedure measured various timing parameters of the baseband video output waveform of an NTSC receiver, with the proponent NTSC-compatible ATV signal applied to the RF input of the receiver. The reference specification was EIA RS 170 A, which is a studio signal specification. Application of that specification to a receiver design is not appropriate. Since this attribute is a receiver implementation issue, it should not be subject to testing by ATTC.

**SECTIONS 8 THROUGH 18 ARE RESERVED FOR AUDIO TEST PROCEDURES, TO  
BE SUPPLIED LATER.**

## 19. Laboratory Testing of Terrestrial Transmission Issues

Transmission issues are divided into two categories -- impairments and interferences. Impairment testing determines the susceptibility of a "desired" signal, provided by the system under test, to various transmission impairments that are simulated by the RF Test Bed. Impairments include random noise, impulse noise, multipath, and airplane flutter. Interference testing involves two RF signals -- a "desired" signal and an "undesired" signal. The signal provided by the proponent system is tested as both desired and undesired, with respect to both an NTSC signal and another, identical, ATV signal. In addition, interference from radio services (discrete frequencies) is simulated by the RF Test Bed.

In all impairment or interference tests, the audio channel performance of the desired signal shall be monitored, measured, and, as appropriate, recorded. When NTSC is the desired signal, the aural carrier power shall be set at ten percent of the visual peak power. The BTSC audio quality will be monitored and recorded. The point at which it degrades or fails will be logged with comments. When NTSC is the undesired signal, aural power shall be set at twenty percent of the visual peak power.

For enhanced NTSC systems under test, the power levels specified above apply to the aural FM carrier and its BTSC modulation. The relative power level of the digital aural subcarrier, and its frequency with respect to the visual carrier, are as specified by the proponent. These parameters shall be logged. If the proponent has supplied a complete digital audio subsystem, with operating analog audio input/output ports, then the audio performance will be monitored. The point at which audio quality degrades will be logged, fully measuring performance. Measurement of digital bit-error rate (BER) also will be made. If the proponent has specified a range of power for the digital subcarrier, then the maximum power shall be used when the ATV signal is the undesired signal; the minimum power shall be used when it is the desired signal. All audio inputs, analog and digital, shall be loaded so that normal modulation is achieved. It may be useful to include intervals of silence in the modulation of the desired signal, in order not to mask low-level noise effects.

Tests of NTSC-to-NTSC interference will be conducted using carrier offsets recommended by the FCC specifically for this testing purpose. The planned RF Test Bed will permit offsets to be resolved to 1 Hz (precision offset).

For testing interference of ATV into ATV, NTSC into ATV, and ATV into NTSC, the offset will be that specified by the proponent, not to exceed  $\pm 1$ -Hz resolution.

Co-channel interference tests may involve two undesired NTSC signals. For these tests, FCC recommendations will be followed for all three carriers.

## 19.1 Susceptibility to Noise

The behavior of NTSC transmission systems in noisy environments has been studied and documented well over the past four decades. Standards have been developed for the weighting of noise measurements, based upon the perceived impairment of luminance and audio performance. The effect of noise upon each of these signal components is a function of the bandwidth, modulation method, and location within the frequency spectrum of that component. These parameters and others, such as time expansion, all may be variables among the various proponent ATV systems. Fundamental studies of the noise susceptibility of each system have not been undertaken, and the temporal weighting factor for noise, and the weighting factor for chroma noise, are unknown.

It is well known that noise in the transmission environment exists in two general forms -- random and impulsive. The effects of both of these forms are evaluated in this section. Results necessarily must be given as unweighted SNR.

### 19.1.1 Random Noise

#### 19.1.1.1 Introduction

Random noise is characterized by a uniform spectral energy distribution. It follows that the noise power is directly proportional to the bandwidth over which it is measured. A useful indicator of the robustness of a transmission method is the ratio of carrier power to random noise power density ( $C/N_0$ ) that is required to deliver pictures of acceptable quality. Both power measurements are taken over the 6-MHz bandwidth of the transmission system.

Carrier power is measured at the peak of sync for an NTSC transmission system, but a different measurement may be required for some ATV systems. For those systems that are not "NTSC-like," the proponent must specify to SS/WP2, well in advance of the test date, his method for specifying carrier power.

A panel of five expert observers shall determine the range of carrier-to-noise ratio over which the test is conducted. As specified in the Subjective Test Procedures Manual, expert observers must have had recent extensive experience in observing picture quality or impairment, particularly of the type under study. Additionally, they must have calibrated or known, rather

than declared, normal color vision. The viewing studio conditions are summarized in Table 14 of the Subjective Test Procedures Manual, and diagrammed in Figure --, General Design and Layout of the Viewing Studio.

The noise power shall be incremented, in 2-dB steps, from 2 dB below the threshold of visibility, noted by these observers, to system failure. In all transmission impairment tests, the digital BER shall be continuously monitored and reported versus the independent variable. Failure of the video is indicated by loss of sync or loss of color. However, in many cases, it is expected that system failure will be manifested as a sudden large increase in BER. The recording of BER versus the independent variable shall be continued past the point at which some would have inferred failure, for the sake of completeness. No point-of-failure judgment will be made based upon increases in BER.

Recordings shall be made, on an appropriate digital videotape recorder (DVTR), of the ATV receiver output of simulcast, augmentation, and enhanced-NTSC systems. Recordings shall be made, on an NTSC D2-VTR, of the NTSC receiver output for both enhanced-NTSC systems and the augmented-NTSC channel of augmentation systems.

#### **19.1.1.2 Test and Measuring Equipment**

The following special test equipment is required:

- (1) A broadband noise source, covering the VHF test channel. This source must have a flat noise energy distribution per unit bandwidth.
- (2) An RF step attenuator, having 1-dB steps, to be applied to the output of the noise source.
- (3) A spectrum analyzer or other instrument suitable for measuring the carrier power.
- (4) An RMS power meter, to measure the noise power in a nominal 6-MHz bandwidth.
- (5) A filter, of calibrated equivalent-noise bandwidth, to be applied to the output of the noise source. The manufacturer of the RF Test Bed shall calibrate this filter.

The ATV video outputs (RGB), from the proponent-supplied Demodulator and Decoder, shall be viewed on the reference color monitor, designed for the scanning standards and aspect ratio of the system under test.

The BER of the the ATV digital audio/data channel will be measured using a suitable bit-pattern generator and error detector. For those systems in which audio subsystems have been implemented, the audio performance will be monitored and measured around the point at which the BER increases suddenly.

For viewing of NTSC signals, an assortment of 25 receivers and a number of VCRs will be furnished to ATTC by the EIA Consumer Electronics Group (EIA/CEG). These units shall represent the current state of the art, but shall not be hand-picked or tweaked by the manufacturer for use by ATTC. Performance shall be verified by the suppliers to be within all production specifications, and copies of measurement data shall accompany the units if possible. In addition, all NTSC signals will be applied to a professional-quality television demodulator, and the baseband video will be viewed on a studio-quality NTSC color monitor. The performance of the BTSC audio channels will be monitored and recorded.

Two DVTRs, one HD and one NTSC, shall be connected to capture the video and audio outputs for any subsequent subjective analysis and for archival purposes.

#### **19.1.1.3 Procedure**

##### **19.1.1.3.1 Setup**

Refer to the Functional Diagram for the Advanced Television Test Center facility, Figure \_\_\_\_\_. The output of each proponent-supplied ATV Modulator is connected to the RF Test Bed through an appropriate proponent-supplied band-pass filter, which may be part of the modulator. The bandwidths of the filtered RF signals are measured by the procedure in Section 6.

In the case of augmented-NTSC systems, comprising main and augmentation channels, two setups are required. For each setup, connect the ATV channel being tested as described below, and connect the other channel by a direct path from the modulator (and band-pass filter) to the demodulator.

Connect the output of the noise source, through an attenuator and calibrated noise bandwidth filter (Item 5), to one input of an RF Combiner. Connect the output of the ATV Modulator to the other input of the Combiner. Connect the output of the Combiner to the band-pass filter. Connect a spectrum analyzer and RMS power meter to a test point at which both carrier and noise power are combined.

Connect the output of a suitable test signal generator, through an attenuator, to the Red, Green, and Blue inputs of the SUT. Select a flat-field test signal, having an amplitude of 350 mV (50 percent of peak white). Use a wideband video distribution amplifier driving equal lengths of identical coaxial cable into 75-ohm terminations at the encoder input.

#### **19.1.1.3.2 Measurement Technique**

Perform the following procedure upon the ATV outputs of all systems, enhanced-NTSC, augmentation, and simulcast, using the demodulator and decoder supplied by the proponent. Also perform this procedure upon enhanced-NTSC systems and the augmented-NTSC channel of augmentation systems, using the reference NTSC demodulator and the EIA-supplied NTSC receivers. The methods for viewing and recording the outputs of the NTSC receivers are described in Appendix --.

With the noise generator output fully attenuated, select a carrier level above the level at which no noise is detectable. Then, adjust the noise attenuator such that the noise level is just perceptible in the picture, as viewed by the expert observers. Use the ascending/descending procedure for threshold level determination that is described in the Subjective Test Procedures Manual. Four of the five expert viewers must agree on this threshold point.

Determine the Carrier-to-Noise power density ratio ( $C/N_0$ ) at the threshold point. First, measure the noise by temporarily disconnecting the modulator from the RF combiner and terminating that input of the combiner. Read the noise power indicated on the RMS power meter. Then, measure the signal by reconnecting the modulator and setting the noise attenuator for maximum attenuation. Read the signal power, at the peak of sync for NTSC, or using the method specified by the proponent as appropriate for his system.

Reduce the noise by 2 dB, and record the video output on the DVTR. Continue to make a series of recordings, incrementing the noise level by 2 dB each time, through the point of system failure.

#### **19.1.1.3.3 Presentation of Data**

The following documentation should be provided for both the ATV output of the proponent-supplied receiver and the NTSC output of the reference NTSC demodulator. Also document the performance of the EIA-supplied NTSC receivers, using the methods of Appendix --.

Log the carrier level used for the testing. Also log the nature of the system failure.

From the measurements of signal power and noise power, at the threshold of visibility, and using the bandwidth measured in Section 6, calculate the  $C/N_0$  ratio per unit bandwidth (BW), as follows:

$$C/N_0 \text{ (per Hz BW)} = 10[\log (\text{Carrier}) - \log (\text{Noise}) + \log (\text{Filter Equiv. Noise BW})]$$

At the threshold of noise visibility, photograph the spectrum analyzer display or obtain a hard-copy output from a printer or plotter, if the instrumentation provides this capability.

Plot BER versus noise power, down to a BER of  $10^{-3}$ . Note, on the noise-power axis of the graph, points of video failure and threshold of visibility of the noise.

Make a 15-second recording on the respective DVTR at each attenuator setting. Note the SMPTE time code at the start of each recording.

### **19.1.2 Impulse Noise**

#### **19.1.2.1 Introduction**

One of the most annoying forms of transmission noise is impulsive, occurring over only a portion of the picture area, and perhaps only briefly, but often at such amplitude that the image is obliterated. These noise impulses may be created by automotive ignition systems or motor-driven electrical

appliances. The effects of impulse noise on NTSC transmission systems are well-known. However, the bandwidth compression techniques employed by various ATV systems may worsen the temporal or spatial characteristics of the noise relative to that observed on an NTSC receiver.

The procedure described below is intended to compare the subjective impairment of the augmentation signal or simulcast signal of an ATV system to that of an NTSC signal, and to evaluate the robustness of the digital audio system.

Expert observers shall determine the amplitude of the impulse noise, using an NTSC transmission path for calibration. Reference DVTR recordings shall be made of these calibration tests. An identical test shall be run immediately thereafter on the proponent ATV system. Recordings of this test shall be made from both the proponent-furnished ATV receiver and the reference NTSC demodulator. The outputs of three of the EIA-supplied NTSC receivers, representing the 10th-, 50th-, and 90th-percentiles of performance, shall be recorded using the method of Appendix --.

#### **19.1.2.2 Test and Measurement Equipment**

The following equipment is required:

- (1) An NTSC test signal generator, having a 50-IRE flat-field output.
- (2) An ATV test signal generator, having a 50-IRE flat-field output.
- (3) An NTSC modulator.
- (4) An NTSC demodulator.
- (5) An impulsive noise source, using a universal AC motor running at a constant load. The noise will be picked up inductively from the motor, amplified, and bandpass filtered into the frequency range of interest (Channel 11 or Channel 23). The impulsive noise power shall be measured by means of a peak-reading RF power meter, through the filter.

An ATV color monitor and an assortment of NTSC receivers and VCRs are required for viewing the outputs of the SUT. These are the same units specified in Section 19.1.1.2, above.

### 19.1.2.3 Procedure

This procedure is segmented into two phases. The first phase is calibration, using an NTSC transmission path. Perform the calibration for each set of expert observations.

#### 19.1.2.3.1 Calibration

Connect the output of an NTSC test signal generator to an NTSC modulator. Set the generator to provide a flat-field test signal having a luminance amplitude of 50 percent. Connect the output of the RF impulse noise generator (Item 5) to one input of an RF Combiner. Connect the output of the NTSC modulator to the other input of the RF Combiner. Connect the output of the RF Combiner to a reference professional-quality NTSC demodulator and to the RF distribution system feeding the bank of EIA-provided NTSC receivers and VCRs. Connect the output of the reference demodulator to a studio-quality NTSC picture monitor and to the NTSC DVTR.

With the noise generator output fully attenuated, set the carrier level 2 dB above the point at which receiver-generated noise is just perceptible by the expert observers.

At the direction of the expert observers, adjust the amplitude of the impulse noise to the point at which the observers feel it is a just-perceptible artifact. This sets the power level of the impulse noise generator. Measure the peak power of the impulse noise through the filter. Make a recording on the NTSC DVTR, and note the SMPTE time code at the start of the recording. Also photograph the NTSC picture monitor.

#### 19.1.2.3.2 Setup for ATV System Test

Connect the output of the ATV flat-field test signal generator to one of the loop-through inputs of a video distribution amplifier. Terminate the other loop-through input in 75 ohms. Connect outputs of this distribution amplifier to the Red, Green, and Blue inputs of the SUT, using equal lengths of identical coaxial cable. Terminate all cables in 75 ohms.